



TENNESSEE DEPARTMENT OF

**EDUCATION**  
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## Mechatronics I

<b>Primary Career Cluster:</b>	Manufacturing
<b>Consultant:</b>	Bethany King Wilkes, (615) 532-2844, <a href="mailto:Bethany.Wilkes@tn.gov">Bethany.Wilkes@tn.gov</a>
<b>Course Code(s):</b>	TBD
<b>Prerequisite(s):</b>	Algebra I (6109/3102), Geometry (6111/3108), Physical Science (3202), Principles of Manufacturing (5922), and Digital Electronics (5925)
<b>Credit:</b>	1
<b>Grade Level:</b>	11
<b>Graduation Requirements:</b>	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Manufacturing courses.
<b>Programs of Study and Sequence:</b>	This is the third course in the <i>Mechatronics</i> program of study.
<b>Necessary Equipment:</b>	Refer to the Teacher Resources page below.
<b>Aligned Student Organization(s):</b>	SkillsUSA: <a href="http://www.tnskillsusa.com">http://www.tnskillsusa.com</a> Brandon Hudson, (615) 532-2804, <a href="mailto:Brandon.Hudson@tn.gov">Brandon.Hudson@tn.gov</a> Technology Student Association (TSA): <a href="http://www.tntsa.org">http://www.tntsa.org</a> Amanda Hodges, (615) 532-6270, <a href="mailto:Amanda.Hodges@tn.gov">Amanda.Hodges@tn.gov</a>
<b>Coordinating Work-Based Learning:</b>	If a teacher has completed work-based learning training, he or she can offer appropriate placement. For more information, please visit <a href="http://www.tn.gov/education/cte/wb/">http://www.tn.gov/education/cte/wb/</a> .
<b>Available Student Industry Certifications:</b>	If a student successfully completes both Mechatronics I and II, he or she is eligible to sit for Level 1 Siemens Certified Mechatronic Systems Assistant certification.
<b>Dual Credit or Dual Enrollment Opportunities:</b>	There are currently dual enrollment opportunities with specific community colleges, such as Motlow State Community College.
<b>Teacher Endorsement(s):</b>	232, 233, 470, 477, 537, 551, 552, 582, 596
<b>Required Teacher Certifications/Training:</b>	None
<b>Teacher Resources:</b>	<a href="http://www.tn.gov/education/cte/Manufacturing.shtml">http://www.tn.gov/education/cte/Manufacturing.shtml</a>

### Course Description

*Mechatronics I* is an applied course in the manufacturing cluster for students interested in learning more about careers as a mechatronics technician, maintenance technician, electromechanical technician, and manufacturing engineer. This first of two courses covers basic electrical and mechanical components of mechatronics systems as well as their combined uses with instrument controls and embedded software

designs. Upon completion of this course, proficient students are able to describe and explain basic functions of physical properties and electrical components within a mechatronic system. They can logically trace the flow of energy through a mechatronic system and can communicate this process to others. They know how to effectively use technical documentation such as data sheets, schematics, timing diagrams, and system specifications to troubleshoot basic problems with equipment. Finally, they develop strategies to identify, localize, and correct malfunctioning components and equipment. Standards in this course are aligned with Tennessee Common Core State Standards in English Language Arts & Literacy in Technical Subjects and Tennessee Common Core State Standards in Mathematics.\*

## Program of Study Application

This course is the third course in the *Mechatronics* program of study. For more information on the benefits and requirements of implementing this program in full, please see the program of study description documents found on the Manufacturing website at <http://www.tn.gov/education/cte/Manufacturing.shtml>.

## Course Standards

### Mechatronics Overview

- 1) Drawing on various media, including visual, quantitative, and written resources, trace the historical development of the four facets (mechanical systems, electronic systems, computers, and control systems) of a mechatronic system and explain their chief applications in modern society, citing specific textual evidence. (TN CCSS Reading 1, 2)
- 2) Citing specific evidence from a textual description or actual observation of a mechatronic system, describe the flow of electrical and mechanical energy in the system. Create a computational model to represent the transfer of energy from one component to others in a system. (TN CCSS Reading 1, 7)

### Safety

- 3) Accurately read and interpret safety rules, including but not limited to rules pertaining to electrical safety, Occupational Safety and Health Administration (OSHA), state and national code requirements. Apply them accordingly while working on electrical and mechanical components and explain why certain rules apply. (TN CCSS Reading 3)

### Electronics

- 4) Demonstrate understanding of the specific roles of various electrical components discerned in a circuit schematic by correctly predicting the effects of changing selected parameter values. For example, predict the effect of halving a resistor's value. Compare and contrast these roles and explain how electronic designs vary within a given system or module. (TN CCSS Reading 3, 9)
- 5) Create, measure, and analyze basic direct current (DC) circuits prescribed by schematics using Ohm's law, Kirchhoff's law, and Watt's law to predict and verify circuit behavior. Apply understanding of these laws to troubleshoot simple circuits, and document the steps required to remedy the trouble. (TN CCSS Reading 3, 4; TN CCSS Writing 4; TN CCSS Math N-Q, A-REI, A-SSE, F-IF)



- 6) Create, measure, and analyze circuits prescribed by schematics to predict and verify the behavior of series versus parallel DC circuits or resistances. Where unexpected behavior is observed, cite specific evidence to explain the observations. (TN CCSS Reading 1)
- 7) Using technical documentation, such as manuals and schematics, craft an informative narrative to explain the physical operation of electromagnetic and electrostatic components (such as coils, solenoids, relays, and various sensors) in a mechatronic system. Interpret resolved work orders by analyzing underlying issues and explaining the correct physical operation of the included components. (TN CCSS Reading 6, 8; TN CCSS Writing 2)
- 8) Create, measure, and analyze circuits prescribed by schematics to predict and verify the behavior of the electrical and physical properties of components (such as resistors, capacitors, diodes, transformers, relays, and power supplies). Report findings explaining the typical application and operation in circuits of the previously listed components, citing measurement and/or observed evidence supporting the explanation. (TN CCSS Reading 8; TN CCSS Writing 4)

## **Mechanical**

- 9) Demonstrate understanding of the specific role of various mechanical components in mechatronic systems, discerning in a system schematic the effects of various design parameters on the system behavior. For example, predict the effect of a larger gear size. Compare and contrast these roles in the context of mechatronic systems, modules, and subsystems, explaining how designs vary within a given system or module. (TN CCSS Reading 3, 9)
- 10) Create, measure, and analyze mechanical systems prescribed by drawings to predict and verify the behavior of the physical operation of components in a mechatronic system, including but not limited to:
  - a. Springs, and spring-like effects
  - b. Dampers and energy dissipation
  - c. Masses (weights)Craft an explanatory narrative to report findings and outline the typical application in systems of the components listed above, citing the observed behavior to support explanations. (TN CCSS Reading 3, 9; TN CCSS Writing 2)
- 11) Interpret technical information in design problems to analyze forces, speeds, torque, and power, for mechanical drives including:
  - a. Gears, cams, screws, and levers
  - b. Belt and chain drives
  - c. Flywheels
  - d. Motors and generatorsExplain the typical application and operation in systems of the components listed above, citing measurement and/or observed evidence to support explanations. Create equations that describe relationships to solve the design problems and justify the solutions. (TN CCSS Reading 4; TN CCSS Math A-CED)



- 12) Research and measure the behavior of different types of alternating current (AC) motors and direct current (DC) motors, comparing and contrasting behaviors and drawing inferences from the observations to create a checklist for use by a technician to ensure proper functioning of equipment. (TN CCSS Reading 1, 9; TN CCSS Writing 4)
- 13) Referencing appropriate technical documents (such as data sheets, timing diagrams, operating manuals, and schematics), design an experiment to observe and measure the mechanical properties and behavior of shafts, couplings, and sealing devices with and without proper lubrication. Document research and measurement results in a technical report to be used by other technicians. (TN CCSS Reading 1, 3; TN CCSS Writing 2, 7, 9)
- 14) Demonstrate understanding of power transmission components, such as clutches and brakes, by measuring the operation of working automotive equipment. Create a graphic illustration showing the roles of each component and how they work together in a system. (TN CCSS Reading 7)
- 15) Assess the required maintenance for a variety of mechatronic system components in a mechatronic device, and carry out the necessary adjustments to the system. Document and justify the adjustments in an equipment log that can be easily referenced by technicians and engineers. (TN CCSS Reading 3; TN CCSS Writing 2)

### Technical Documentation and Troubleshooting

- 16) Consult technical documents (such as data sheets, timing diagrams, operating manuals, and schematics) to assess a mechatronic system and effectively troubleshoot the malfunctions in electrical components. Record and analyze test results and prepare written testing documentation to justify a solution. (TN CCSS Reading 5, 9; TN CCSS Writing 1, 2)
- 17) Verify by observation and measurement the parts, relationships, and behavior depicted by the technical data sheets for the mechanical and electrical components within a mechatronic system. Use these data sheets to create a training document to instruct a new technician on maintaining and operating these components and drives. (TN CCSS Reading 4, 5; TN CCSS Writing 2)

### Standards Alignment Notes

\*References to other standards include:

- TN CCSS Reading: [Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects](#); Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 11-12 Students (page 62).
  - Note: While not directly aligned to one specific standard, students who are engaging in activities outlined above should be able to also demonstrate fluency in standard 10 at the conclusion of the course.
- TN CCSS Writing: [Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects](#); Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 11-12 Students (pages 64-66).



- Note: While not directly aligned to one specific standard, students who are engaging in activities outlined above should be able to also demonstrate fluency in Standards 3, 5, 6, 8, and 10 at the conclusion of the course.
- TN CCSS Math: [Tennessee Common Core State Standards for Mathematics](#); Math Standards for High School: Number and Quantity, Algebra, Functions (pages 58-83).
  - Note: The standards in this course are not meant to teach mathematical concepts. However, the concepts referenced above may provide teachers with opportunities to collaborate with mathematics educators to design project based activities or collaborate on lesson planning. Students who are engaging in activities listed above should be able to demonstrate quantitative, algebraic, and functional reasoning as applied to specific technical concepts. In addition students will have the opportunity to practice the habits of mind as described in the eight Standards for Mathematical Practice.
- P21: Partnership for 21st Century Skills [Framework for 21st Century Learning](#)
  - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

